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A NOTE ON THE LAST STAGE OF THE ICE AGE IN CENTRAL SCANDINAVIA

IN the Dovre region which lies to the north of Christiania the main divide runs in an east-westerly direction. On the mountain plateaus of this region the parent rock of much of the drift

is found on the southern side of the divide; consequently the ice had its movement upstream, at least during part of the ice age.

Dr. Andre M. Hansen has given a reasonable explanation of this fact which may be illustrated by the following diagram, Fig. 2.

The country is steeper on the north side of the divide (*a n*) than on the south side (*a s*). The contour of the ice-cover, on the other hand, formed a rather regular curve, and the movement in it took place from the thickest and highest part (*b*) outward to both sides. Consequently on the stretch (*c a*) the movement was against the slope of the surface as indicated by the largest arrow of the diagram.

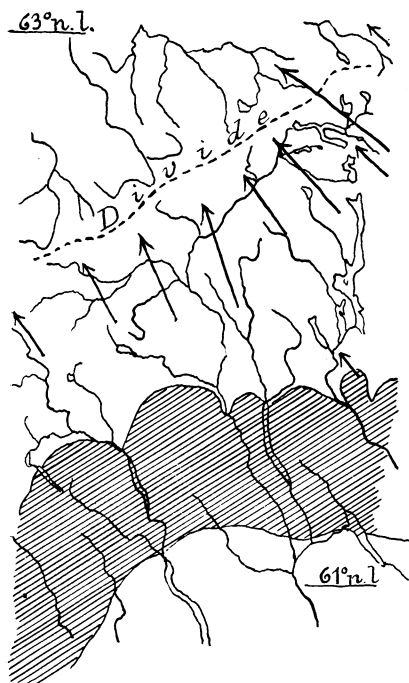


FIG. 1.—The Dovre region in Norway. The arrows mark the movement of the ice. The shaded part is the last remnant of the great ice according to Dr. Andre M. Hansen.

Now let us leave for a moment this question of the ice movement and turn to another phenomenon. In the upper parts of the valleys to the south of the divide, strand-lines occur of the same kind as the much discussed "parallel roads"

of the Scottish Highlands. The explanation is the same in Norway as in Scotland; they are the beaches of lakes which were dammed in by ice during the late glacial time. Dr. Hansen has tried to give an elaborate account of the manner in which this came about. He thinks that the ice melted latest where the thickness was greatest, and that the last remnants came to lie as a narrow strip of ice, a sort of "ice sausage," on the slope of the south of the divide and somewhat parallel to it (see Fig. 1). On the diagram the shaded part shows the ice in the last stage, and the lakes were dammed in between it and the divide. The readers of this JOURNAL may remember that this

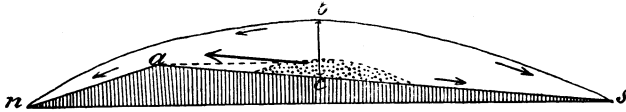


FIG. 2.

explanation was hinted at in a paper by Dr. Hansen, entitled "Glacial Succession in Norway," Vol. II, 1894, p. 137, conclusions, by the way, to which most Norwegian geologists assent only to a limited extent.

By his explanation Dr. Hansen has made urgent the question at what place the last remnants of the inland ice were located. Mr. Schiötz, professor of physics at the University of Christiania, has criticised Mr. Hansen's views from the physical standpoint in a paper entitled "How will the ice divide act during the melting of the inland ice?" printed (in Norwegian) in *Nyt Magazin for Naturvidenskaberne*, Vol. 34, Chr., 1895, pp. 102-111. He demonstrates that any "ice sausage" on the slope below the divide can come into existence only in the case that the melting takes place so suddenly and quickly that the snow line during the period of melting is at a greater height than the crest of the country. If the snow line rises gradually as the temperature rises, the diminishing glaciers will concentrate at the divide. He thinks this the most probable case, and points to the great local glaciers which undoubtedly have descended from the

divide, and to the fact that small local glaciers still exist in the region described. If Mr. Hansen is right, the snow line was first very much elevated, then descended below its present limit, and more recently has ascended again to produce the present conditions.

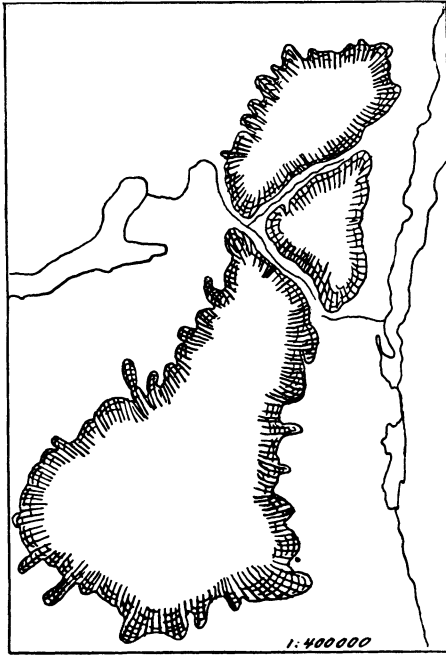


FIG. 3.—The Folgefonn glacier-field.

It seems to the present writer that a study of the now existing Scandinavian glaciers makes another explanation of the ice-dammed lakes more probable than that set forth by Dr. Hansen. It may be remembered that the region in question is to be regarded as a high plateau intersected by valleys. Our chief existing glaciers are also found in country of the same kind, and in accordance therewith they present themselves as gently-domed or shield-like snow-fields, intersected by valleys free of snow. This has long been known of the two great snow-fields of

southern Norway, "The Folgefonn" and "The Justedalsbrae." The Folgefonn, for instance, is dissected by valleys into three parts, as seen on the accompanying map. In size the Folgefonn is the second among the Scandinavian glaciers. The greatest is the Justedalsbrae. Next to this comes "The Svartisen" (Svart = swarthy, blackish; isen = ice), situated under the polar circle. Even on our latest maps this glacier has been delineated as an unbroken elliptical snow-field with its greatest dimensions from south to north, although Mr. Rekstad of the Norwegian Geological Survey had shown in 1891 that the snow-field is divided

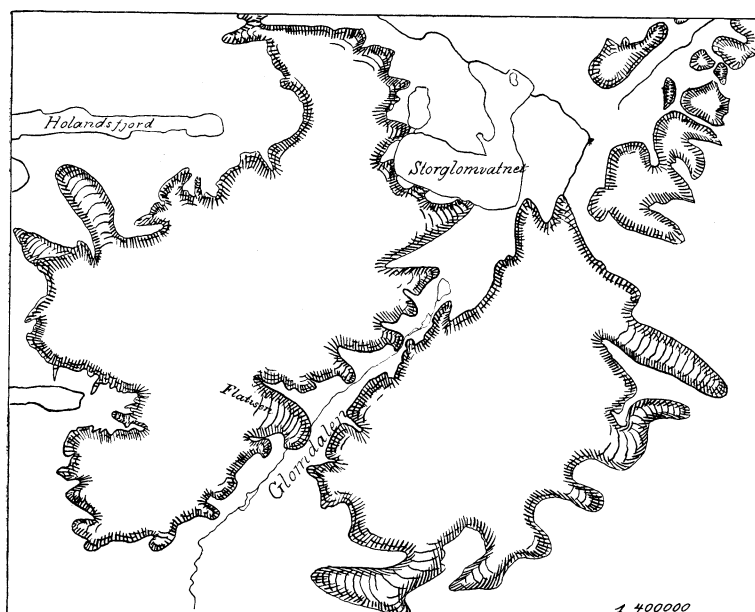


FIG. 4.—The Glacier of Svartisen.



FIG. 5.—Glaciers descending from the Svartisen to the Glomdal valley.

into two by a desert valley, the Glomdal (dal = valley). He was the first Norwegian known to have entered the inner part of that valley formerly known only to a few Laps, an incident which indicates that geographical discoveries may yet be made within Europe itself. He has described and photographed the principal

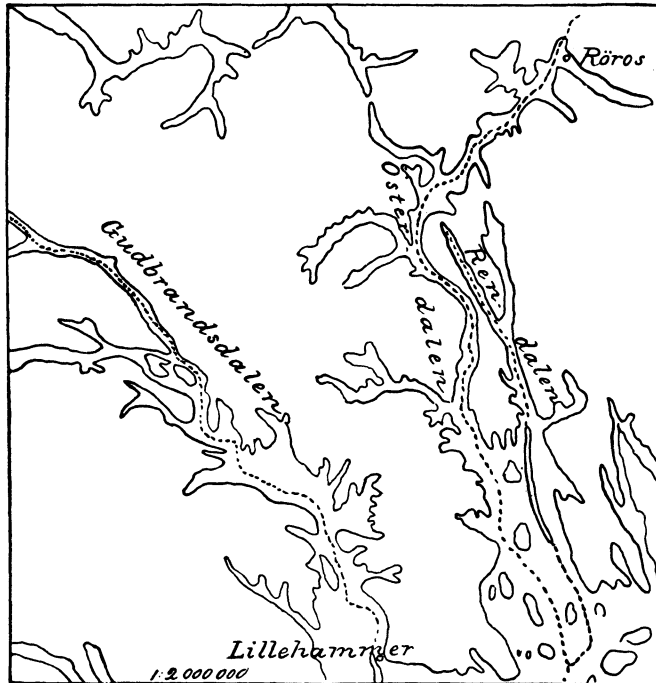


FIG. 6.—The region in the vicinity of the main Scandinavian divide to the north of Christiania. The line of 100 meters above the sea is shown.

glaciers descending into the Glomdal. The greatest is presented herewith. The Norwegian Topographical Survey has of late made a more detailed map of the region. With the aid of their material, which has not as yet been published, the present sketch map was made, Fig. 4.

If we now turn to the region of the old ice-dammed lakes, we find a country well fitted for similar extensive fields of ice and snow, with empty valleys between. The map (Fig. 6),

shows how the line of 100 meters encompasses narrow branching valleys. We may easily imagine that during a certain stage of the melting this line was the snow line and determined the extension of the snow-fields. Some glacier descending from one of the greater side-valleys may have stopped back the water of the main valley and formed a lake. Mr. Rekstad says that the river that issues from the Glomdal valley sometimes

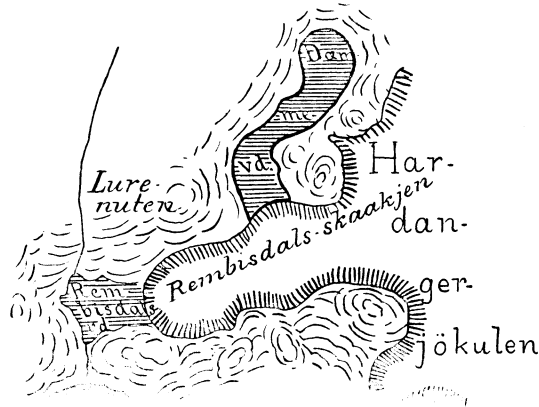


FIG. 7.—The Daemnevand (dammed lake) in Hardanger.

rises enormously, and that the flood is probably due to the fact that the water is temporarily obstructed by the chief glacier that intrudes upon the valley. Norway has its Märjelen See corresponding to the famous Swiss lake as is well known among geologists through Lyell's Principles. The Norwegian glacier-dammed lake is the Daemnevand (the blocked-up lake) in the province of Hardanger, in the high region to the east of the town of Bergen. From an extensive snow-field, the "Hardanger jökul" (jökul = glacier) descends to a lake. On its way it blocks up the "Daemnevand." This lake has of late attracted some attention, as the water sometimes breaks through the glacier and causes sudden and destructive floods. To prevent this the government has made a tunnel about 300 meters long

through a spur of the mountain called Turumeten. This tunnel has had the effect desired in preventing the lake rising above a fixed level. Mr. A. Holmsen, who had the supervision of the work, has had the kindness to communicate a sketch-map (Fig. 7) of the surroundings of the lake, and a photograph of the blockading glacier with a part of the lake in the foreground.



FIG. 8.—The ice barrier in front of the lake Daemme, sketched from a photograph.

From a dam like this we may mentally reconstruct a barrier capable of accounting for the lakes dammed back in olden time in the Dovre region.

There are two English accounts of this lake, viz., that of Mockler-Ferryman ("The Daemnevand of Rembesdals Glacier Lake, *Geogr. Jour.*, IV, Dec. 1894, London, pp. 524-528) and that of Munro ("On a Remarkable Glacier Lake formed by a branch of the Hardanger-Jökul, near Eidjford, Norway, *Proc. of the Roy. Soc. of Edinburgh*, Session 1892-3, Vol. XX, pp. 53-82). The two Norwegian scientists, Bing and Öyen have also made reports on the lake.

HANS REUSCH.